

T-1011 Run Summary

Tests of radiation-hard silicon microstrip
sensors for CMS in S-LHC

(March 16-29, 2011)

CMS Tracker

Pixel region

Barrel, Forward

66M channels!

PSI46 chip

- 52×80 pixels
- Sparcified at detector

Replacement in S-LHC phase I/II

- $10^{16} 1 \text{ MeV } n_{\text{eq}}$

Beam telescope at FNAL based on CAPTAN system

- $\sim 1 \text{ cm}^2$ beam spot required

Strip region

TIB, TID, TOB, TEC

200 m² sensor area!

APV25 chip

- 128 channels
- Sparcified off detector

Replacement in S-LHC phase II

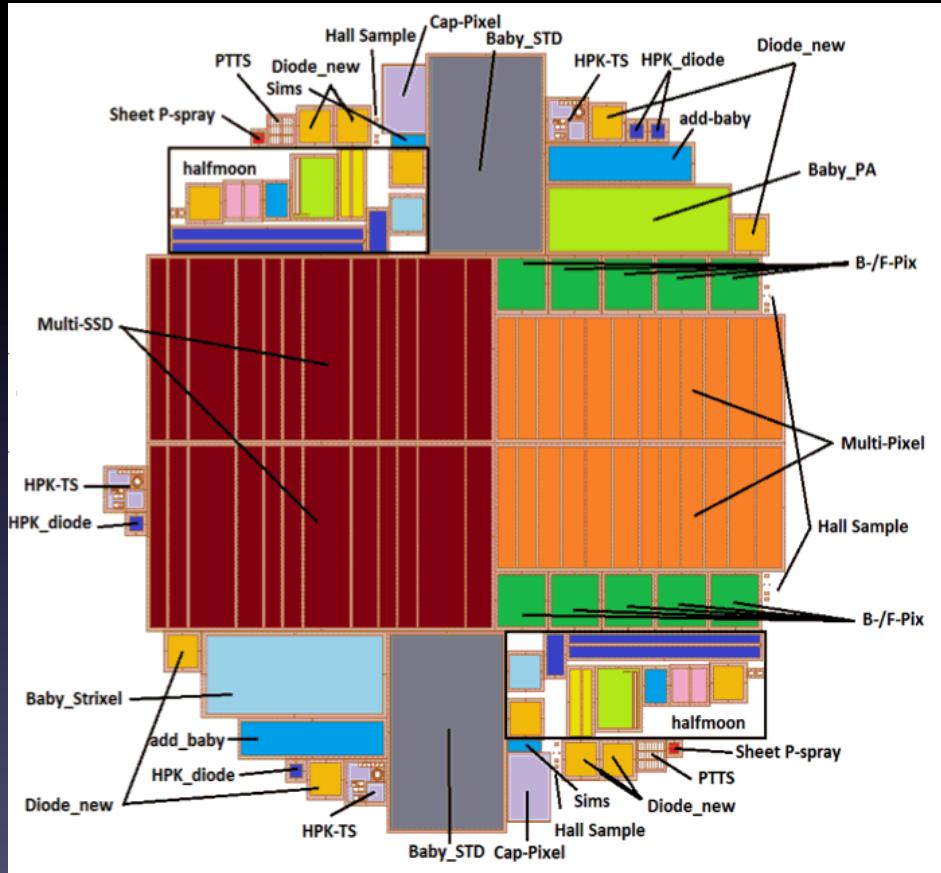
- $10^{15} 1 \text{ MeV } n_{\text{eq}}$

Beam telescope at CERN/FNAL based on APV hybrids, CMS DAQ

- Designed for $4 \times 4 \text{ cm}^2$ areas

Two separate test beam efforts

CMS “HPK Campaign”



Over 100 6 inch wafers (Float Zone, Magnetic Czochralski, Epitaxial)
Bulk doping: n-type, p-type (p-stop, p-spray)

Silicon Beam Telescope (SiBT) Group

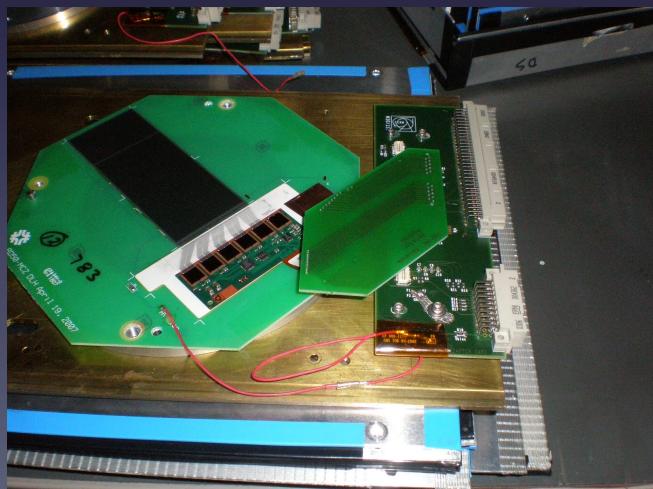


- The SiBT group has participated in 5 beam tests in the CERN H₂ line since 2007
 - Original focus was to explore Magnetic Czochralski silicon as a radiation hard option for S-LHC strip tracker regions.

<http://www.hip.fi/research/cms/tracker/SiBT/php/home.php>

Silicon Beam Telescope

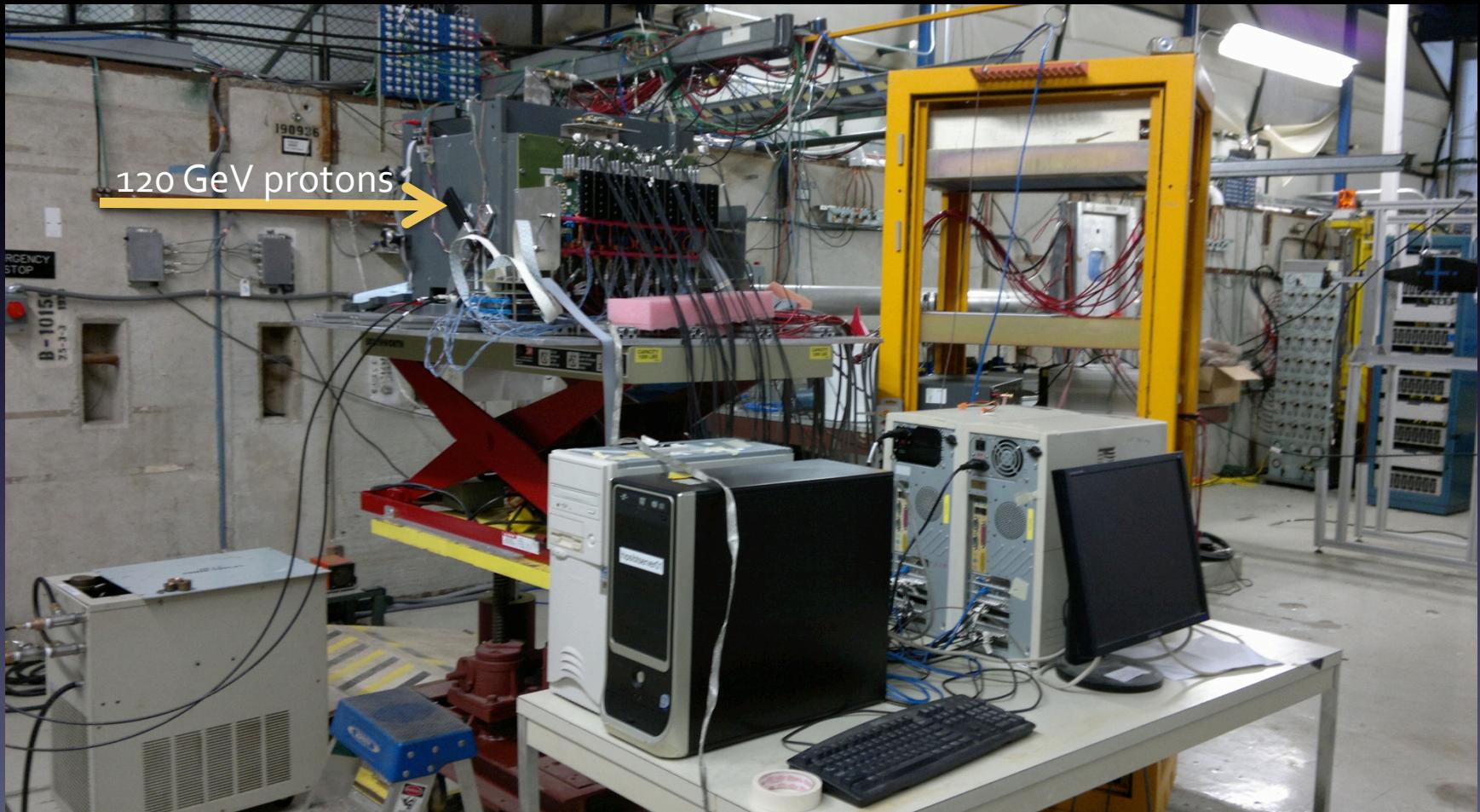
- Redeployed CMS “Vienna” system
- Telescope includes 4+4 reference planes and 2 DUT slots
- Reference planes at $\pm 45^\circ$ orientations due to height limitation
- Reference detectors are DO Run IIb HPK sensors (60 μm pitch with intermediate strips, 639 channels)
- Telescope active area is $4 \times 4 \text{ cm}^2$.
- Readout electronics: CMS (TOB) hybrids
- DAQ software is a modified version of XDAQ



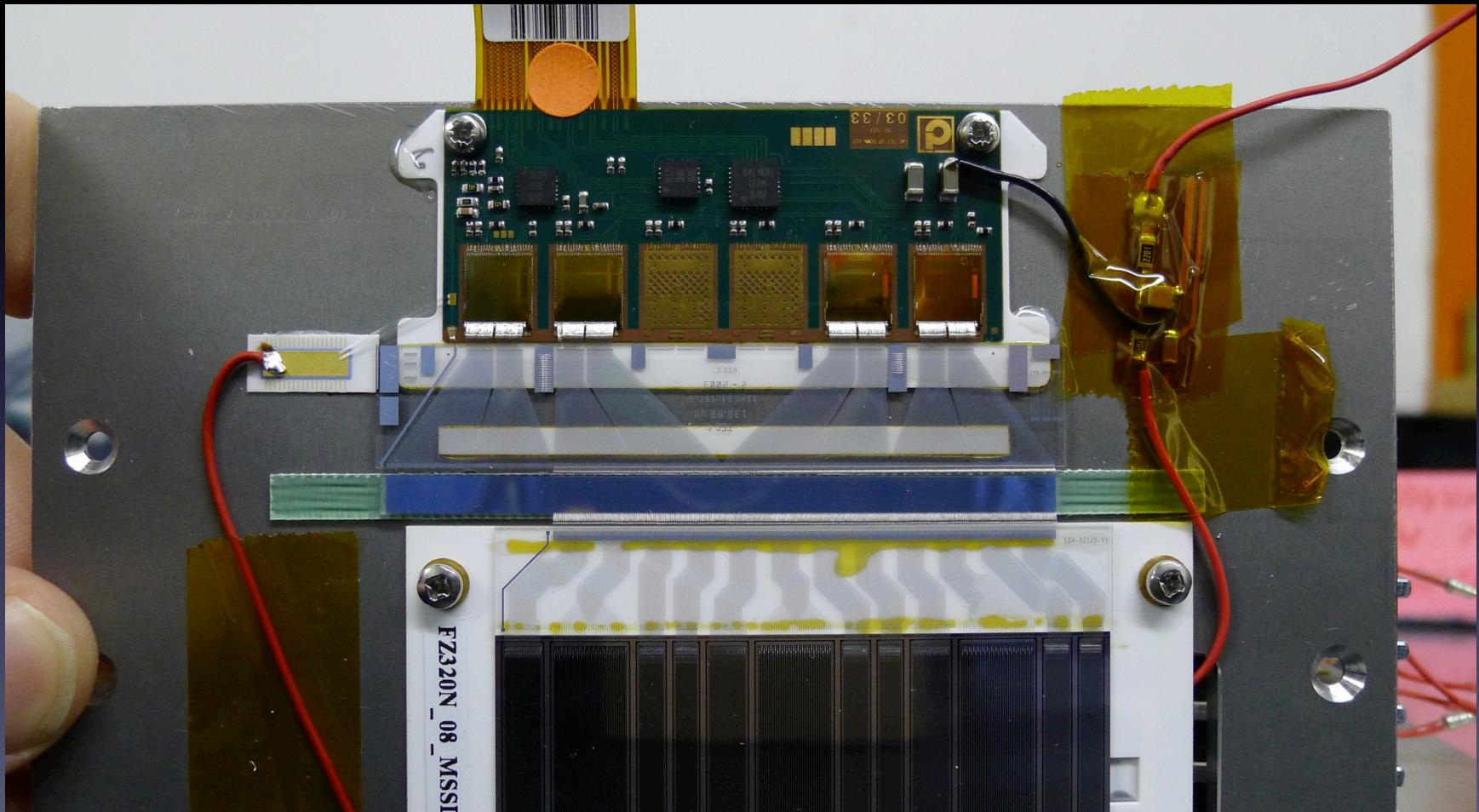
T-1011 Personnel

- Brown University
 - A. Garabedian, D. Tersegno
- CERN
 - G. Auzinger
- FNAL
 - L. Spiegel
- HIP (Helsinki Institute of Physics)
 - D. Fusi, P. Luukka, T. Mäenpää,
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- KIT (Universität Karlsruhe)
 - K. Hoffman
- Wayne State University
 - P. Lamichhane

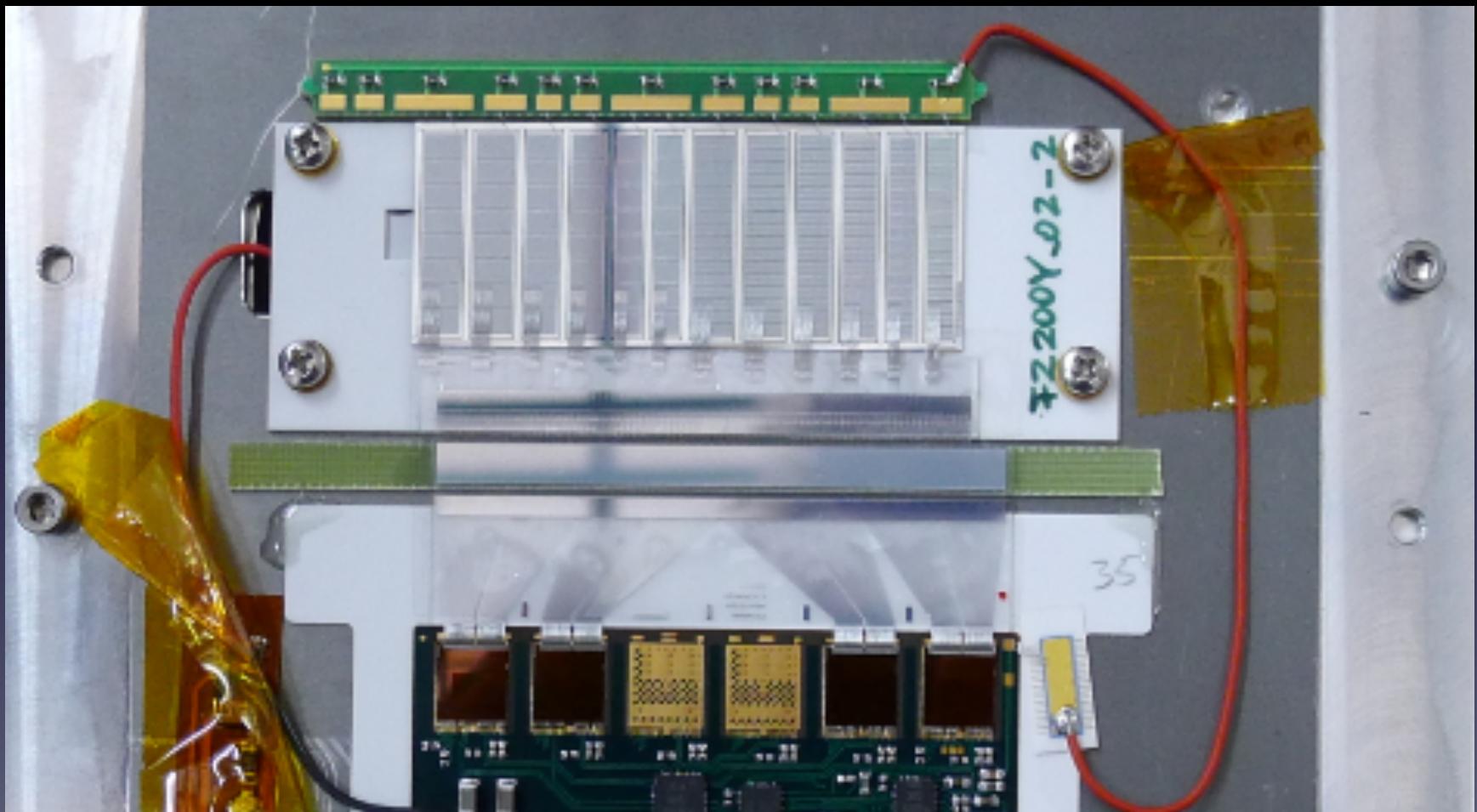
SiBT@FTBF



HPK sensor + CMS hybrid



Mpix Module

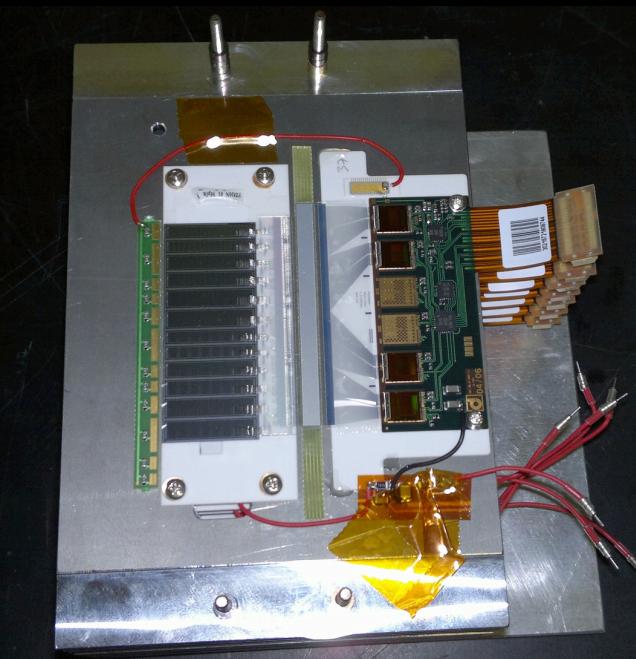


Timeline

- March 15 – Received beam telescope late in afternoon
- March 18 – Safety approval
- March 19 – Commissioning
- March 20 – Start taking data with first set of DUTs
- March 23 – Double spills starting in the afternoon!
- March 24 – No beam all day
- March 27 – Main program completed. Install “time permitting” modules

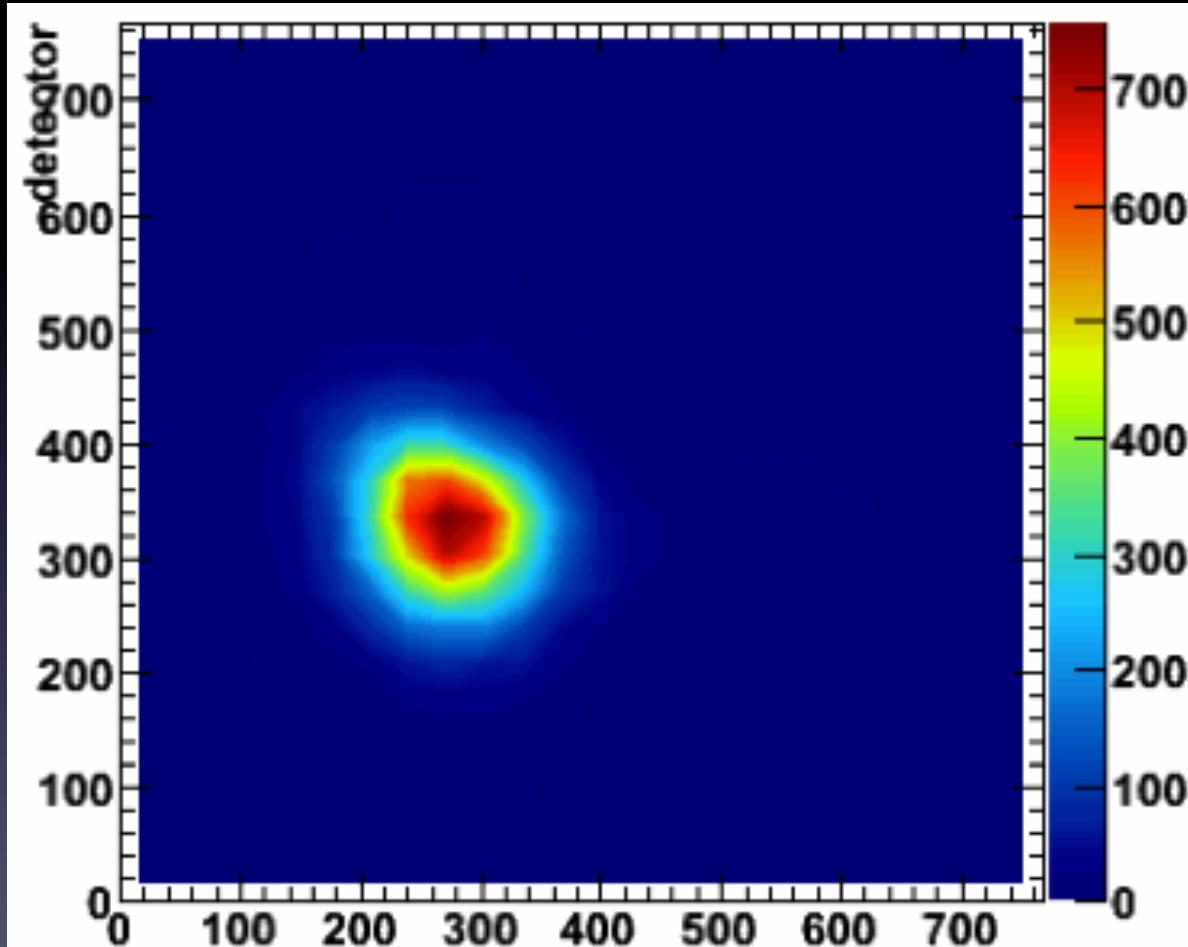
MSSD and Mpixel Modules

- | | |
|---------------------|------------------|
| 1) FZ320N_o8_MSSD_1 | FZ200N_o6_Mpix_1 |
| 2) FZ320P_o1_MSSD_1 | FZ320N_o1_Mpix_1 |
| 3) FZ200N_o1_MSSD_1 | FZ320P_o4_Mpix_1 |
| 4) FZ120N_o2_MSSD_2 | FZ120N_o6_Mpix_1 |
| 5) FZ320Y_o4_MSSD_2 | FZ320Y_o5_Mpix_2 |
| 6) FZ200P_o4_MSSD_1 | FZ200P_o1_Mpix_2 |
| 7) FZ200Y_o2_MSSD_2 | FZ220Y_o2_Mpix_2 |
| 8) E100N_o2_MSSD_1 | E100N_o2_Mpix_1 |
| 9) E50N_o2_MSSD_1 | E50N_o2_Mpix_1 |



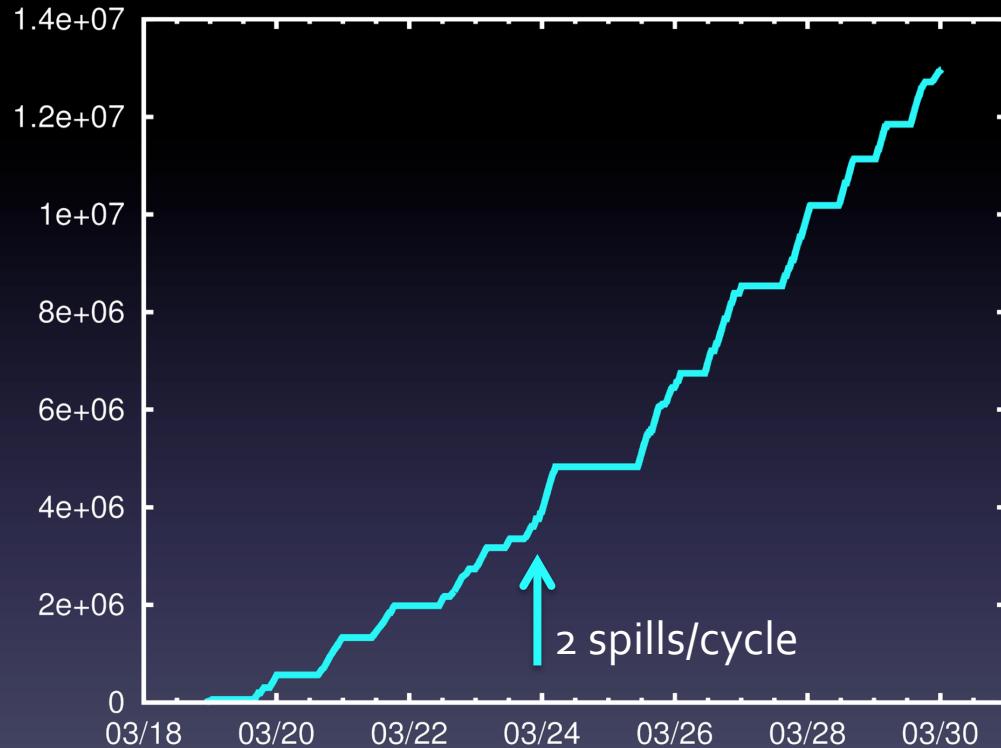
Bonus modules

Online Beam Profile



~1 cm² beam spot, preferred by primary user (T-992), required 7 table positions per voltage setting to cover 12 distinct regions per MSSD/Mpixel module.

Event Accumulation

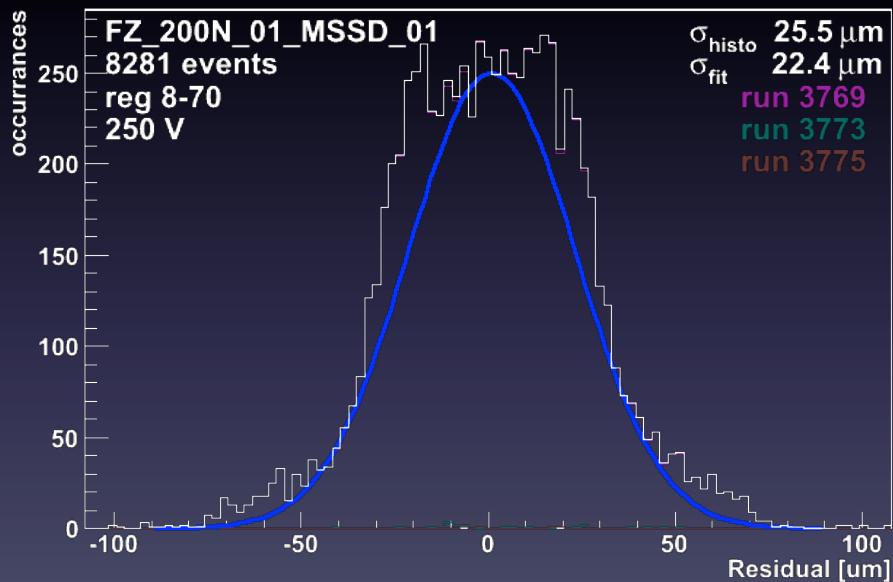


333 runs, 50k events per typical run

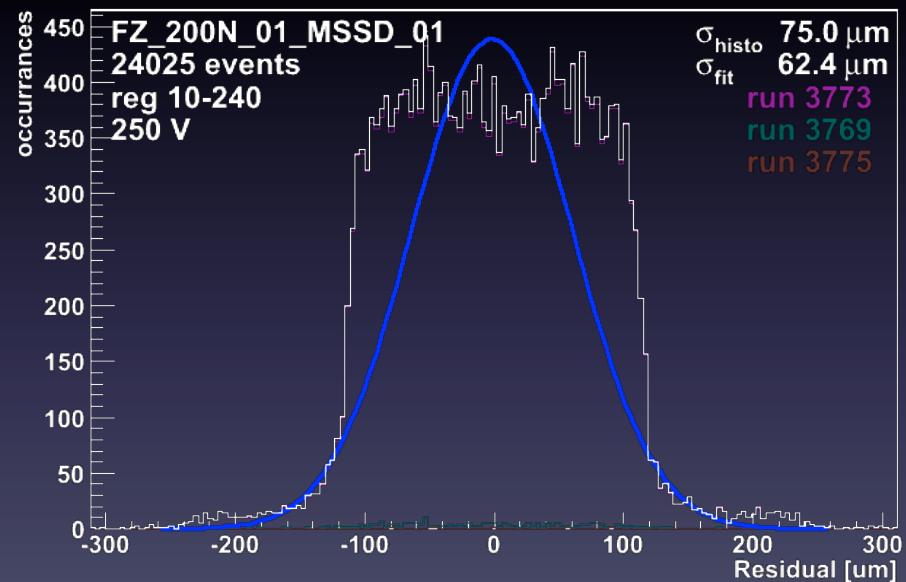
Offline Analysis

Initial processing (alignment) now underway at Helsinki

$s = 70 \mu\text{m}$



$s = 250 \mu\text{m}$



The interpolation accuracy at slots 5 and 6 is $\sim 6 \mu\text{m}$ since the DUTs were mounted at 0° and the reference planes are at $\pm 45^\circ$.

Thanks!

- The T-1011 group would like to express their gratitude for the many people at Fermilab who helped make the test beam run a success. In particular, we note the promptness in which the Lab responded to a request to double the number of spills per cycle. Without this change we would not have been able to complete our program.